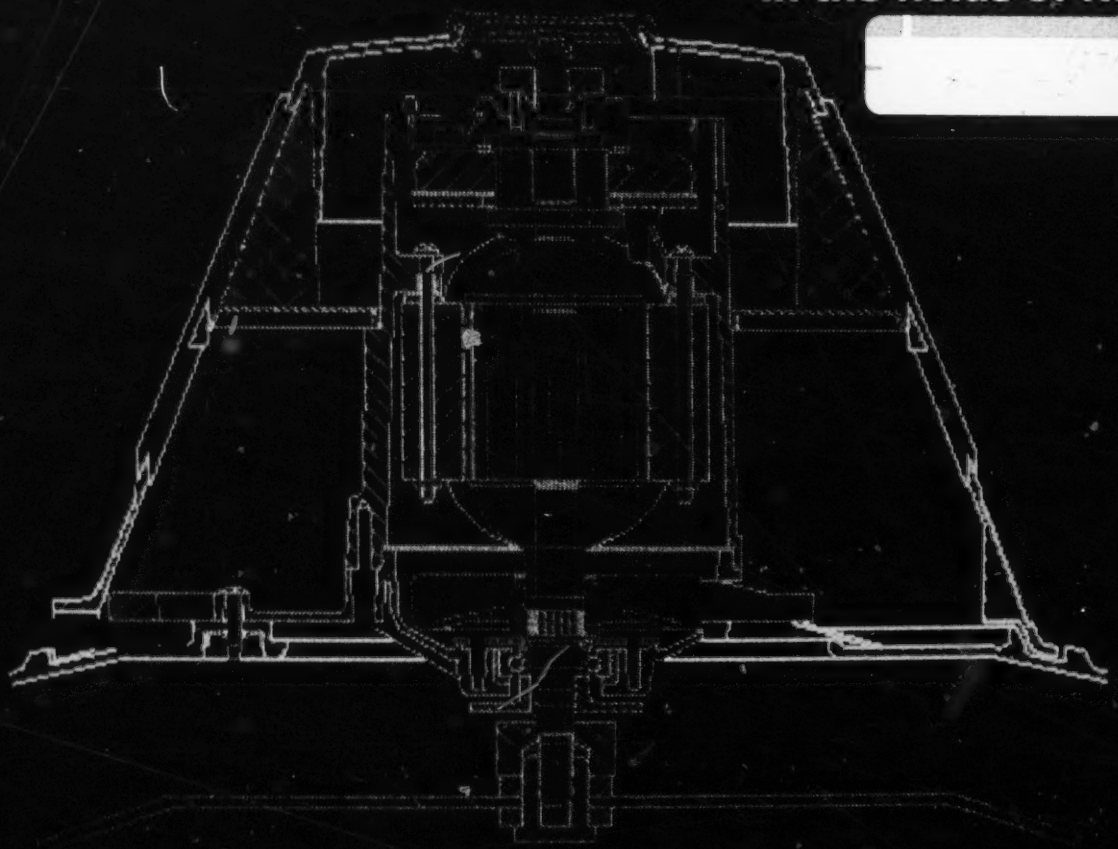
INDUSTRIAL RESEARCH & DEVELOPMENT

NOVEMBER 1983

1983 Scientist of the Year lecture:
Finding gold nuggets in the fields of R&D



color graphics effectively

ical and electronic testing

• in quality assurance

• present instrument uses; plans to acquire

News of importance to people in R&D

Color displays can enhance visualization. See p 105.

INDUSTRIAL RESEARCH & DEVELOPMENT

SERVING THE $156.7-BILLION WORLDWIDE R&D INDUSTRY

EDITORIAL

11 **An industrial policy for the U.S.? No way!**

DEPARTMENTS

17 **Innovative notebook**
25 **Product development**
31 **A lawyer's view**
37 **Research trendletter**
41 **R/D news in brief**
141 **Vacuum technology**
153 **Special new products**
155 **R&D product center**
159 **New products**
171 **Literature**
200 **Bookshelf**
204 **Letters**
206 **Advertisers index**
209 **Reader service card**

ABOUT THE COVER

Color in graphics displays does more than provide another pretty picture. It can help to separate background from foreground, one month's data from another's, temperature or time differences. The choices are almost limitless. Color also can be used to identify hazardous items, different circuits, different sources.

But all of this requires special considerations in the design of the color graphics system. An article on the physiology and psychology of color as applied to color graphics displays begins on p 105.

Cover photo from Tektronix Inc.

Technical Publishing

a company of The Dun & Bradstreet Corporation

ABP BPA

NEWS OF SCIENCE AND TECHNOLOGY

49 **Science policy:** NAS urges that lab waste disposal curbs be eased; Nobel in Medicine recognizes Barbara McClintock's contributions; joint R&D will benefit from relaxed antitrust laws; space shuttle 'comes of age'
51 **Space:** NASA's plans for a space station become a political issue
51 **Measurement:** Laser probes inside chemical reactors
52 **Physics:** U.S. physicists pursue massive SSC collider
54 **Chemistry:** Process provides greater control over polymerization
56 **Electronics:** IBM's 512-kbit chip sets up future marketing battle
56 **Satellites:** IRAS success results from advanced technologies; shelter adds flexibility to Antarctic exploration
62 **Astronomy:** Quasar brightness tied to its gravitational energy; 'unique' pulsar could hold clues about how they form
66 **Propulsion:** Ramjet research soars with component advances; Westinghouse opens plasma development center; wind tunnel will aid design of future shuttles
70 **Conferences:** Labcon experiences another successful year
70 **Awards:** 'Lab of Year' competition begins; *I•R 100* entry forms available
73 **Nuclear:** Swedish method encapsulates nuclear fuel rods in copper
74 **Architecture:** Researchers test 'base isolation' to minimize earthquake damage; pipeline plow wins engineering award

Special Report—Aviation

79 Aircraft R&D brightens industry picture with advances in engine components, airframe design, and increased use of composite materials

ARTICLES

90 **Applied scientist may be standing in field of R&D gold nuggets:** James N. Shoolery, Varian Assoc.; Scientist of the Year says R&D climate helped project.

98 **Thermocouples, RTDs can boost temperature measurement accuracy:** Bob O'Brien and Stephen Miller, John Fluke Mfg. Co.; new tools are accurate.

105 **Good color graphics are a lot more than another pretty display:** Gerald M. Murch, Tektronix Inc.; good graphics consider psychology and physiology.

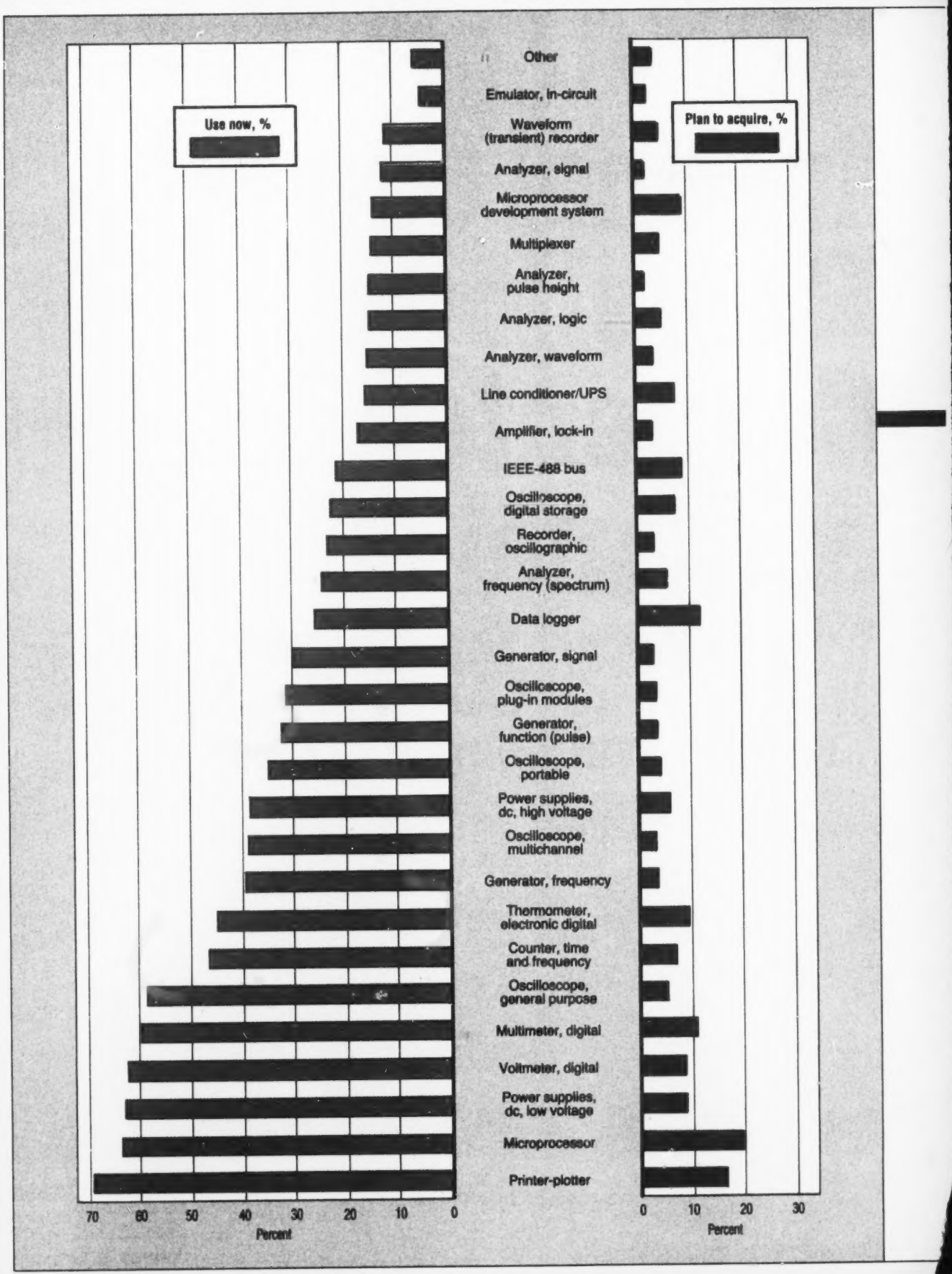
112 **Al casting waste cut by monitoring molten metal cooling curve:** D. Apelian, Drexel Univ., and N.G. Walker, Metallurgical Products & Technologies.

118 **Use of electrical and electronic instruments:** C.J. Mosbacher, executive editor, *IR&D*; industrial R&D plans to acquire fewer instruments this year.

124 **FT-MS uses image current detector to get high mass resolution:** W.D. Bowers, R.L. Hunter, and R.T. McIver Jr., Univ. of California, Irvine.

132 **XRF spectroscopy offers alternative to optical methods:** Gideon Kramer, Kevex Corp.; technique depends on unique characteristics.

141 **Deposition machine uses rodless cylinder to simplify wafer handling:** Jack Dimock, Sputtered Films Inc.; system design provides reliability.


Use now, %
Plan to acquire, %
Other
Emulator, in-circuit
Waveform (transient) recorder
Analyzer, signal
Microprocessor development system
Multiplexer
Analyzer, pulse height
Analyzer, logic
Analyzer, waveform
Line conditioner/UPS
Amplifier, lock-in
IEEE-488 bus
Oscilloscope, digital storage
Recorder, oscillographic
Analyzer, frequency (spectrum)
Data logger
Generator, signal
Oscilloscope, plug-in modules
Generator, function (pulse)
Oscilloscope, portable
Power supplies, dc, high voltage
Oscilloscope, multichannel
Generator, frequency
Thermometer, electronic digital
Counter, time and frequency
Oscilloscope, general purpose
Multimeter, digital
Voltmeter, digital
Power supplies, dc, low voltage
Microprocessor
Printer-plotter
70 60 50 40 30 20 10 0
Percent
0 10 20 30
Percent

C.J. Mosbacher
Executive editor

TRENDSURVEY

Use of electrical and electronic instruments

Plans to acquire new instruments plunge more than 12% according to replies to this year's study, despite somewhat higher plans in the university and science sectors over last year.

WHATEVER GAIN occurred last year in plans to acquire new electrical and electronic instruments for use in R&D will be wiped out in the next year. That's what 1,057 respondents to this year's Trendsurvey tell us with their replies. Average present use this year is 32.2%, and average plans to acquire for 30 instrument categories is 6.2%.

But these numbers cannot be compared directly with results of last year's survey; only 26 instrument categories are the same. Operational amplifiers, universal bridges, analog multimeters, and analog storage oscilloscopes, which were included last year, have been replaced with in-circuit emulators, UPS/line conditioners, multiplexers, and oscillographic recorders in this year's study.

For the 26 unchanged categories, present use this year is 34.9%; last year it was 36.1%. Plans to acquire are 6.6% compared to 7.4% last year.

Still, this does not take into account changes in the demographics from last year to this. When the data are normalized to take this into account, present use for this year rises to 35.5%, which is a drop of 0.65%—less than a 2% change—from last year. But plans to acquire drop almost 1% when normalized, and this is a change of 12.4%.

Thus the Trendsurvey strongly indicates a decrease in instrument acquisitions planned in the next year. Augmenting this indication is an increase of almost 5%—from 44.4% to 46.6%—in the portion of respondents who have no plans to acquire any instruments at all within one year.

The only sector showing a significant increase in plans to acquire is the university, or academic, area. This can be attributed to major increases in Federal funding of research projects, which is also indicated by increased plans in the science sectors. But these are more than offset by diminished plans in the industrial sector and in the engineering disciplines.

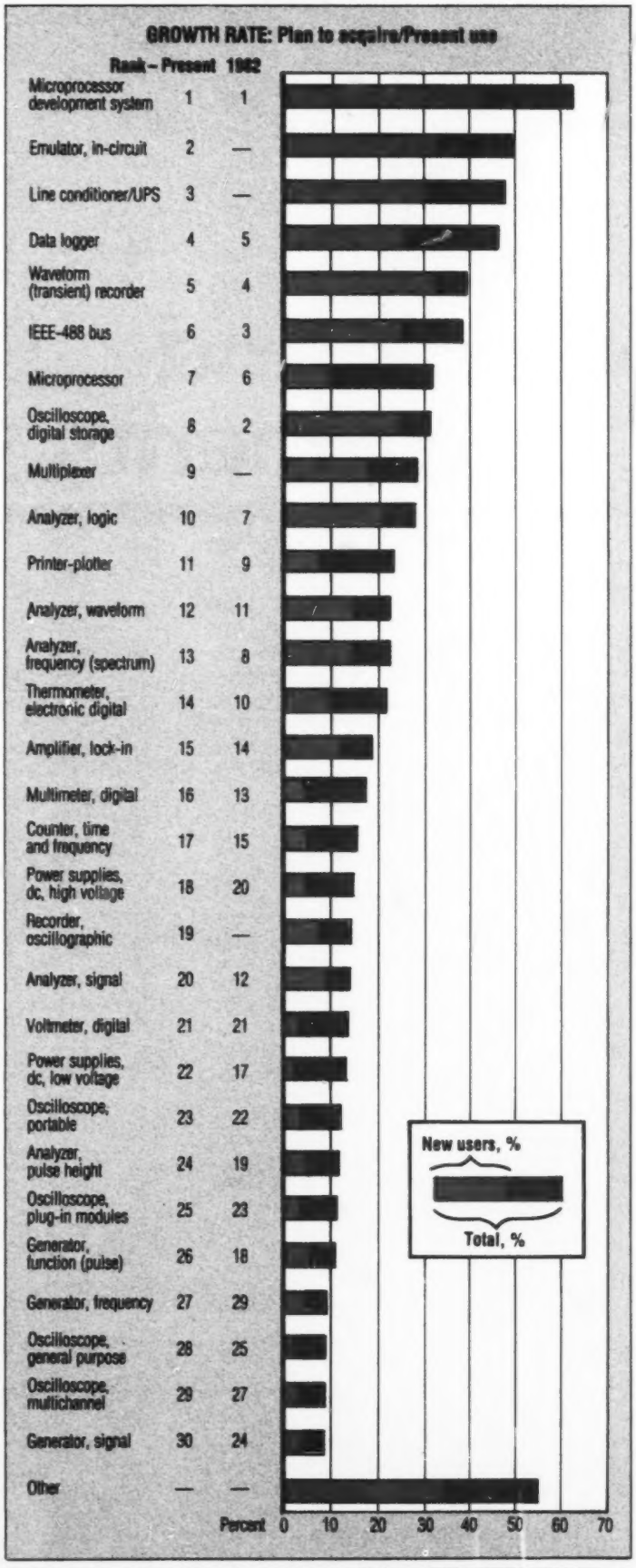
Results of the Trendsurvey are presented graphically on these pages. Present use and plans to acquire are graphed as a percent of the total number of respondents on the first page.

Growth rates calculated with present use of a particular instrument as the base are summarized in the chart on the third page. This chart shows the total growth rate and the rate for new users—those who indicated they do not presently use an instrument but who plan to acquire it in the next year. Rankings this year and last are also given on the growth rate chart.

Complete data giving numbers of respondents as well as percentages for the total sample and disciplines are given in the table on the last page of this article for both growth and growth rate.

Average present use and plans to acquire varied among the demographic groups. The following paragraphs summarize these averages for this year. To provide a means of comparing this year's data with last year's, averages are also given for the 26 instruments that are the same for both years.

By discipline, and without the "Other" category, present use averages 38.9% and plans to acquire average 6.9% for engineering. Comparable figures for physical science are 28.5% and 5.7%, and for life science and medicine 22.6% and 5.8%. For the 26 categories, the corresponding numbers are 41.9% and 7.1%, 31.3% and 6.0%, and


GROWTH RATE: Plan to acquire/Present use
Rank – Present 1982
Microprocessor development system 1 1
Emulator, in-circuit 2 —
Line conditioner/UPS 3 —
Data logger 4 5
Waveform (transient) recorder 5 4
IEEE-488 bus 6 3
Microprocessor 7 6
Oscilloscope, digital storage 8 2
Multiplexer 9 —
Analyzer, logic 10 7
Printer-plotter 11 9
Analyzer, waveform 12 11
Analyzer, frequency (spectrum) 13 8
Thermometer, electronic digital 14 10
Amplifier, lock-in 15 14
Multimeter, digital 16 13
Counter, time and frequency 17 15
Power supplies, dc, high voltage 18 20
Recorder, oscillographic 19 —
Analyzer, signal 20 12
Voltmeter, digital 21 21
Power supplies, dc, low voltage 22 17
Oscilloscope, portable 23 22
Analyzer, pulse height 24 19
Oscilloscope, plug-in modules 25 23
Generator, function (pulse) 26 18
Generator, frequency 27 29
Oscilloscope, general purpose 28 25
Oscilloscope, multichannel 29 27
Generator, signal 30 24
Other — —
New users, %
Total, %
Percent 0 10 20 30 40 50 60 70

24.0% and 6.0% this year, compared to 42.0% and 9.0%, 31.2% and 5.6%, and 22.8% and 4.7% respectively for 1982.

By employer, industry averages 30.8% present use and 5.9% plans to acquire, universities 37.1% and 7.8%, nonprofit organizations 35.9% and 6.6%, medical research centers 26.2% and 6.3%, and other (including government) 31.1% and 5.4%. For the 26 categories, corresponding numbers are 33.3% and 6.2%, 40.5% and 8.4%, 39.0% and 7.2%, 28.2% and 5.8%, and 31.1% and 5.6% this year, compared to 34.2% and 7.3%, 38.4% and 7.2%, 41.4% and 10.1%, 38.5% and 8.9%, and 39.0% and 6.5% for 1982.

Corporate officers have average present use of 32.6% and average plans to acquire of 6.0%, R&D executives 35.0% and 9.2%, project managers 34.5% and 7.3%, professional staff 31.8% and 5.7%, and other 28.4% and 4.9%. For the 26 comparable categories, the corresponding numbers are 34.9% and 6.3%, 37.4% and 9.8%, 37.4% and 7.6%, 34.6% and 6.0%, and 31.6% and 5.3% this year, and 36.4% and 10.7%, 33.5% and 10.1%, 39.9% and 9.1%, 34.7% and 6.7%, and 40.7% and 7.1% for 1982.

As is to be expected, the demographics of respondents vary from year to year. In this year's survey, 3.0% are corporate officers, 7.0% R&D executives, 17.1% project managers, 66.3% professional staff, and 4.2% other. Last year, the corresponding numbers were 4.3%, 7.3%, 15.8%, 65.7%, and 5.8%. Note that the totals are less than 100% because some respondents did not answer all questions.

By discipline, 43.6% of this year's respondents gave engineering as their primary discipline, 40.7% physical science, and 12.2% life science or medicine. The corresponding 1982 figures were 52.6%, 35.7%, and 9.3% respectively. Thus there was a significant shift toward the sciences.

Slightly less of a shift occurred from industry to the academic and nonprofit areas. This year, 52.6% of respondents work in industry, 19.6% in universities, 7.4% in nonprofit organizations, 2.6% in medical research centers, and 14.9% elsewhere. In 1982, the corresponding numbers were 57.8%, 18.6%, 6.3%, 2.4%, and 12.3%.

In geographic terms, the distribution of respondents once again correlates well with the *IR&D* circulation, which in turn correlates with R&D activity in the United States. New England accounts for 7.2% of respondents, Middle Atlantic 15.3%, East North Central 18.8%, West North Central 5.3%, South Atlantic 13.0%, East South Central 3.5%, West South Central 6.6%, Mountain 5.1%, and Pacific 16.6%. No answer was provided by 8.6% of respondents.

As with earlier Trendsurveys, this study was conducted by including a prepaid reply postcard in a mailing to domestic *IR&D* subscribers. The mailing was done in late May, and by early August, 1,057 cards that provided the data included here had been returned. □

PRESENT AND PLANNED USE: Data from 1,057 respondents

	Use now								Plan to acquire within 1 year								Growth rate = plan to acquire ÷ by present use			
	Total, 1,057		Engineering, 461		Physical science, 430		Life science or medicine, 129		Total, 1,057		Engineering, 461		Physical science, 430		Life science or medicine, 129		Total	Present users who plan to acquire		New users
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	%	No.	%	%
Amplifier, lock-in 1982	179	16.9 17.8	68	14.8	87	20.2	21	16.3	32	3.0 3.3	9	2.0	20	4.7	3	2.3	17.9	12	6.7	11.2
Analyzer, frequency (spectrum) 1982	258	24.4 23.2	155	33.6	84	19.5	12	9.3	58	5.5 6.3	35	7.6	20	4.7	1	0.8	22.5	22	8.5	14.0
Analyzer, logic 1982	154	14.6 14.4	98	21.3	38	8.8	10	7.8	43	4.1 4.8	27	5.9	8	1.9	7	5.4	27.9	11	7.1	20.8
Analyzer, pulse height 1982	154	14.6 14.0	52	11.3	83	19.3	13	10.1	18	1.7 2.0	5	1.1	10	2.3	3	2.3	11.7	11	7.1	4.5
Analyzer, waveform 1982	159	15.0 15.3	92	20.0	56	13.0	8	6.2	36	3.4 3.3	22	4.8	11	2.6	1	0.8	22.6	13	8.2	14.5
Analyzer, signal 1982	135	12.8 16.2	73	15.8	48	11.2	10	7.8	18	1.7 3.3	11	2.4	5	1.2	2	1.6	13.3	6	4.4	8.9
Counter, time and frequency 1982	492	46.5 49.9	275	59.7	161	37.4	42	32.6	75	7.1 8.7	42	9.1	22	5.1	9	7.0	15.2	48	9.8	5.5
Data logger 1982	275	26.0 26.0	152	33.0	100	23.3	16	12.4	125	11.8 11.0	61	13.2	44	10.2	17	13.2	45.5	51	18.5	26.9
Emulator, in-circuit 1982	49	4.6 —	36	7.8	8	1.9	3	2.3	24	2.3 —	16	3.5	3	0.7	4	3.1	49.0	8	16.3	32.7
Generator, frequency 1982	421	39.8 45.2	249	54.0	130	30.2	30	23.3	38	3.6 4.0	22	4.8	11	2.6	5	3.9	9.0	21	5.0	4.0
Generator, function (pulse) 1982	339	32.1 35.6	195	42.3	114	26.5	23	17.8	36	3.4 5.3	25	5.4	9	2.1	2	1.6	10.6	17	5.0	5.6
Generator, signal 1982	316	29.9 34.5	186	40.3	98	22.8	21	16.3	27	2.6 3.8	15	3.3	8	1.9	4	3.1	8.5	15	4.7	3.8
IEEE-488 bus 1982	227	21.5 20.5	120	26.0	91	21.2	10	7.8	86	8.1 9.3	42	9.1	34	7.9	6	4.7	37.9	30	13.2	24.7
Line conditioner/UPS 1982	163	15.4 —	79	17.1	57	13.3	23	17.8	77	7.3 —	36	7.8	29	6.7	10	7.8	47.2	28	17.2	30.1
Microprocessors 1982	670	63.4 56.6	306	66.4	275	64.0	76	58.9	209	19.8 20.3	87	18.9	87	20.2	26	20.2	31.2	148	22.1	9.1
Microprocessor development systems 1982	149	14.1 15.8	85	18.4	49	11.4	10	7.8	92	8.7 8.8	43	9.3	31	7.2	12	9.3	61.7	31	20.8	40.9
Multimeter, digital 1982	633	59.9 69.2	329	71.4	246	57.2	45	34.9	107	10.1 13.2	57	12.4	37	8.6	12	9.3	16.9	80	12.6	4.3
Multiplexer 1982	150	14.2 —	88	19.1	46	10.7	11	8.5	43	4.1 —	22	4.8	15	3.5	5	3.9	28.7	16	10.7	18.0
Oscilloscope, digital storage 1982	240	22.7 18.4	142	30.8	74	17.2	15	11.6	74	7.0 8.8	45	9.8	21	4.9	7	5.4	30.8	17	7.1	23.8
Oscilloscope, general purpose 1982	618	58.5 60.0	315	68.3	231	53.7	55	42.6	54	5.1 6.3	24	5.2	25	5.8	5	3.9	8.7	39	6.3	2.4
Oscilloscope, multichannel 1982	411	38.9 43.9	243	52.7	121	28.1	31	24.0	35	3.3 4.3	21	4.6	12	2.8	2	1.6	8.5	22	5.4	3.2
Oscilloscope, plug-in modules 1982	327	30.9 36.1	187	40.6	103	24.0	25	19.4	36	3.4 4.0	14	3.0	19	4.4	2	1.6	11.0	24	7.3	3.7
Oscilloscope, portable 1982	368	34.8 35.9	214	46.4	116	27.0	25	19.4	44	4.2 4.6	21	4.6	17	4.0	5	3.9	12.0	29	7.9	4.1
Power supplies, dc, high voltage 1982	406	38.4 40.7	176	38.2	169	39.3	49	38.0	60	5.7 5.8	23	5.0	26	6.0	10	7.8	14.8	42	10.3	4.4
Power supplies, dc, low voltage 1982	669	63.3 66.7	342	74.2	239	55.6	69	53.5	87	8.2 10.7	42	9.1	31	7.2	12	9.3	13.0	68	10.2	2.8
Printer-plotters 1982	737	69.7 64.2	309	67.0	318	74.0	87	67.4	170	16.1 16.4	70	15.2	70	16.3	23	17.8	23.1	115	15.6	7.5
Recorder, oscillographic 1982	246	23.3 —	150	32.5	60	14.0	32	24.8	33	3.1 —	18	3.9	11	2.6	4	3.1	13.4	14	5.7	7.7
Thermometer, electronic digital 1982	476	45.0 46.1	245	53.1	181	42.1	37	28.7	102	9.6 10.0	45	9.8	43	10.0	11	8.5	21.4	55	11.6	9.9
Voltmeter, digital 1982	661	62.5 59.1	336	72.9	253	58.8	55	42.6	87	8.2 7.7	40	8.7	34	7.9	11	8.5	13.2	66	10.0	3.2
Waveform (transient) recorder 1982	127	12.0 13.1	76	16.5	39	9.1	9	7.0	50	4.7 5.9	28	6.1	17	4.0	4	3.1	39.4	9	7.1	32.3
Other 1982	64	6.1 6.3	28	6.1	24	5.6	11	8.5	35	3.3 2.2	20	4.3	12	2.8	2	1.6	54.7	13	20.3	34.4